

## CLAIMS:

1. A method for generating training data ( $D_T$ ) for an automatic speech recogniser  
(2) for operating at a particular first sampling frequency ( $f_H$ ), comprising the following  
steps:
  - deriving spectral characteristics ( $S_L$ ) from audio data ( $D_L$ ) sampled at a  
5 second frequency ( $f_L$ ) lower than the first sampling frequency ( $f_H$ );
  - extending the bandwidth of the spectral characteristics ( $S_L$ ) by retrieving  
bandwidth extending information ( $I_{BE}$ ) from a codebook (6);
  - processing the bandwidth extended spectral characteristics ( $S_{LE}$ ) to give  
the required training data ( $D_T$ ).
- 10 2. A method according to claim 1, where the conversion of audio data ( $D_H$ ,  $D_L$ )  
into sets of spectral characteristics ( $S_H$ ,  $S_L$ ) comprises calculating the FFT of the audio  
data ( $D_H$ ,  $D_L$ ) to give a set of Fourier coefficients (31) and filtering the output of the  
FFT with a filterbank (22) to give a set of filterbank power values (32).
- 15 3. A method according to claim 2, where the conversion of audio data ( $D_H$ ,  $D_L$ )  
into sets of spectral characteristics ( $S_H$ ,  $S_L$ ) comprises processing the FFT coefficients  
(31) or the filterbank power values (32) to give a set of log-spectral coefficients (33).
- 20 4. A method according to any of claims 1 to 3, where the processing of bandwidth  
extended spectral characteristics ( $S_{L,E}$ ) comprises a step of altering the spectrum to  
adjust signal properties of the audio data ( $D_L$ ).
5. A method according to claim 4, where the step of altering the spectrum to adjust  
25 the signal properties of the audio data ( $D_L$ ) is performed in the linear domain.

6. A method according to any of claims 1 to 5, where the derivation of the spectral characteristics ( $S_L$ ) from audio data ( $D_L$ ) is followed by a step subtracting the mean spectrum from the spectral characteristics ( $S_L$ ).
- 5 7. A method for training an automatic speech recognition system (2) wherein the data ( $D_T$ ) used for training are at least partially generated using a method according to any of claims 1 to 6.
8. A method for generating a codebook (6) for extending the bandwidth of spectral  
10 characteristics ( $S_L$ ) for audio data ( $D_L$ ) sampled at a second sampling frequency ( $f_L$ ) to spectral characteristics ( $S_H$ ) for a first sampling frequency ( $f_H$ ) higher than the second sampling frequency ( $f_L$ ), comprising the following steps for each entry of the codebook (6):
- deriving a first set of spectral characteristics ( $SC_H$ ) from audio data  
15 ( $DC_H$ ) sampled at the first sampling frequency ( $f_H$ );
  - performing a sampling rate transformation on the audio data ( $DC_H$ ) to the second sampling frequency ( $f_L$ ) and deriving a corresponding second set of spectral characteristics ( $SC_L$ );
  - generating a codebook entry (12) based on the second set of spectral  
20 characteristics ( $SC_L$ ) and augmenting the codebook entry (12) with additional higher frequency information from the first set of spectral characteristics ( $SC_H$ ).
9. A method according to claim 8, where augmenting the codebook entry (12)  
25 comprises extracting information from the corresponding first set of spectral characteristics ( $S_H$ ) pertaining to the frequencies above the second sampling frequency ( $f_L$ ) and attaching this information to the codebook entry (12) in the codebook (6).
10. A method according to claim 8 or 9, where the derivation of the second set of  
30 spectral characteristics ( $SC_L$ ) is followed by a background noise reduction and/or channel normalization step.

11. A method according to claim 10, where the spectral characteristics ( $SC_L$ ) comprise a log-spectral representation, and the channel normalization is performed by subtracting the mean log spectrum from the log spectral characteristics ( $SC_L$ ).
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12. A method according to claim 10, where the spectral characteristics ( $SC_L$ ) comprise a linear spectral representation, and the background noise reduction is performed by subtracting a background noise spectrum from the linear spectral characteristics ( $SC_L$ ).
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13. A method according to claim 11 and 12, where the background noise reduction is performed by subtracting a background noise spectrum from a linear spectral characteristics ( $SC_L$ ) subsequently calculating the logarithm and then subtracting the mean log spectrum from the log spectral characteristics
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14. A system (1) for generating training data ( $D_T$ ) for an automatic speech recogniser (2) operating at a particular first sampling frequency ( $f_H$ ), comprising:
- a converter (3) for deriving spectral characteristics ( $S_L$ ) from audio data ( $D_C$ ) sampled at a second frequency ( $f_L$ ) lower than the first sampling frequency ( $f_H$ );
  - a retrieval unit (4) for retrieving bandwidth extending information for the spectral characteristics ( $S_L$ ) from a codebook (6);
  - a processing module (7) for processing the bandwidth-extended spectral characteristics ( $S_{L,E}$ ) to give the required training data ( $D_T$ ).
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15. A system (5) for generating a codebook (6) for extending the bandwidth of a set of spectral characteristics ( $S_L$ ) for audio data ( $D_L$ ) sampled at a second sampling frequency ( $f_L$ ) to a set of spectral characteristics ( $S_H$ ) for a first sampling frequency ( $f_H$ ) higher than the second sampling frequency ( $f_L$ ), comprising:
- a converter (9) for deriving a first set of spectral characteristics ( $SC_H$ ) from audio data ( $DC_H$ ) sampled at the first sampling frequency ( $f_H$ );
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- a module (10) for performing a sampling rate transformation on the audio data ( $DC_H$ ) to the second sampling frequency ( $f_L$ ) and for deriving a corresponding second set of spectral characteristics ( $SC_L$ ) for the second sampling frequency ( $f_L$ );
- 5       - a codebook entry generator (11) for generating an entry (12) for the codebook (6) based on a second set of spectral characteristics ( $SC_L$ ) and for augmenting the codebook entry (12) with additional higher frequency information from the corresponding first set of spectral characteristics ( $SC_H$ );

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